

Integrating Health Protection and Health Promotion to Reduce Musculoskeletal Injury: Partnering with the Fire Service

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The Problem

- Musculoskeletal injuries are the most common injury among firefighters*
 - Account for about 50% of all firefighter injuries
 - Costly
 - Most occur during EMS operations
 - Overexertion is primary cause – lifting, carrying, twisting, bending
 - Job requires a high level of physical fitness
 - Fire service is interested in addressing the problem
 - Minimal research on topic

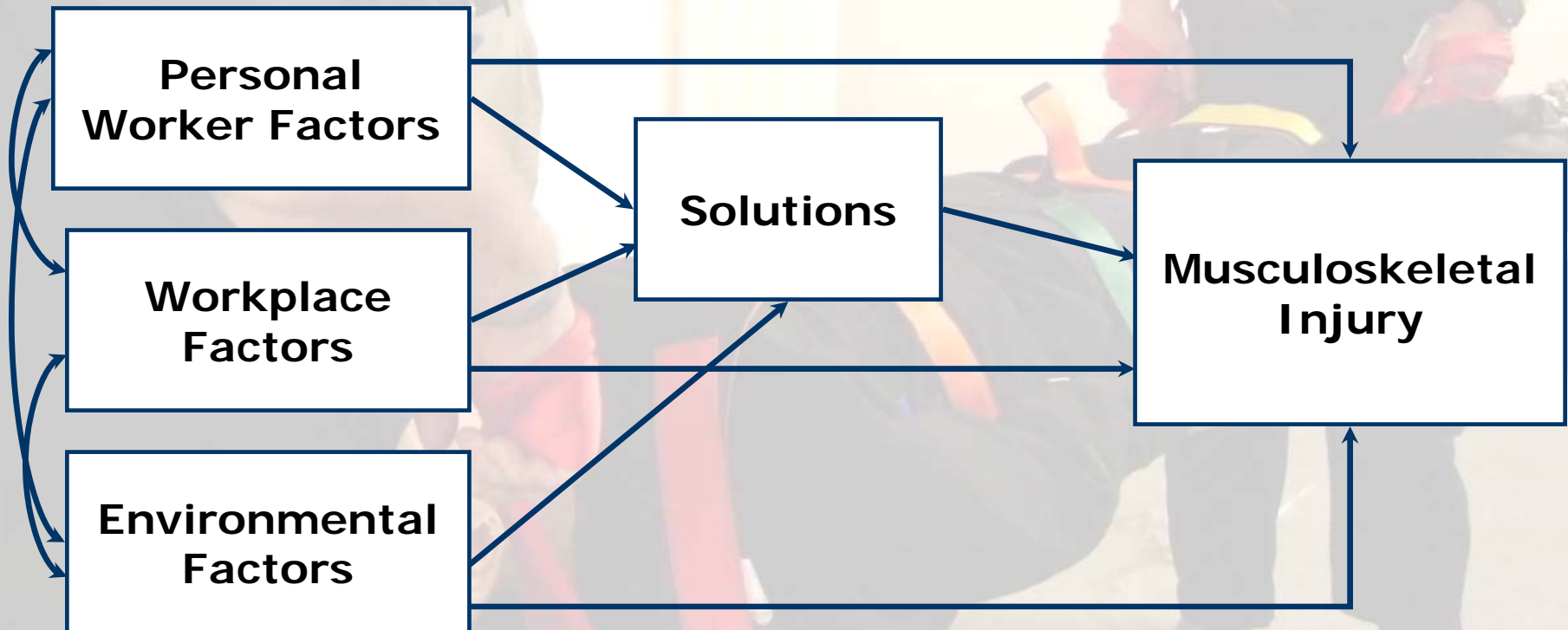
*See references at end of presentation

Today's Objectives

- Highlight the findings from our program of research
 - The focus is on reducing musculoskeletal injury in firefighter/paramedics
 - Ergonomics
 - Physical fitness
- Demonstrate the importance of integrating health protection and health promotion to address the problem

It's not either or – it's both!

Ecological Model of Factors Influencing Musculoskeletal Injury in the Fire Service



STUDY 1

Identifying the Problem Using Focus Groups

5 focus groups

- 39 fire chiefs and firefighters
- 14 fire departments

"What does it mean to be injured?"

"What **workplace factors** do you think contribute to musculoskeletal injury on the job?"

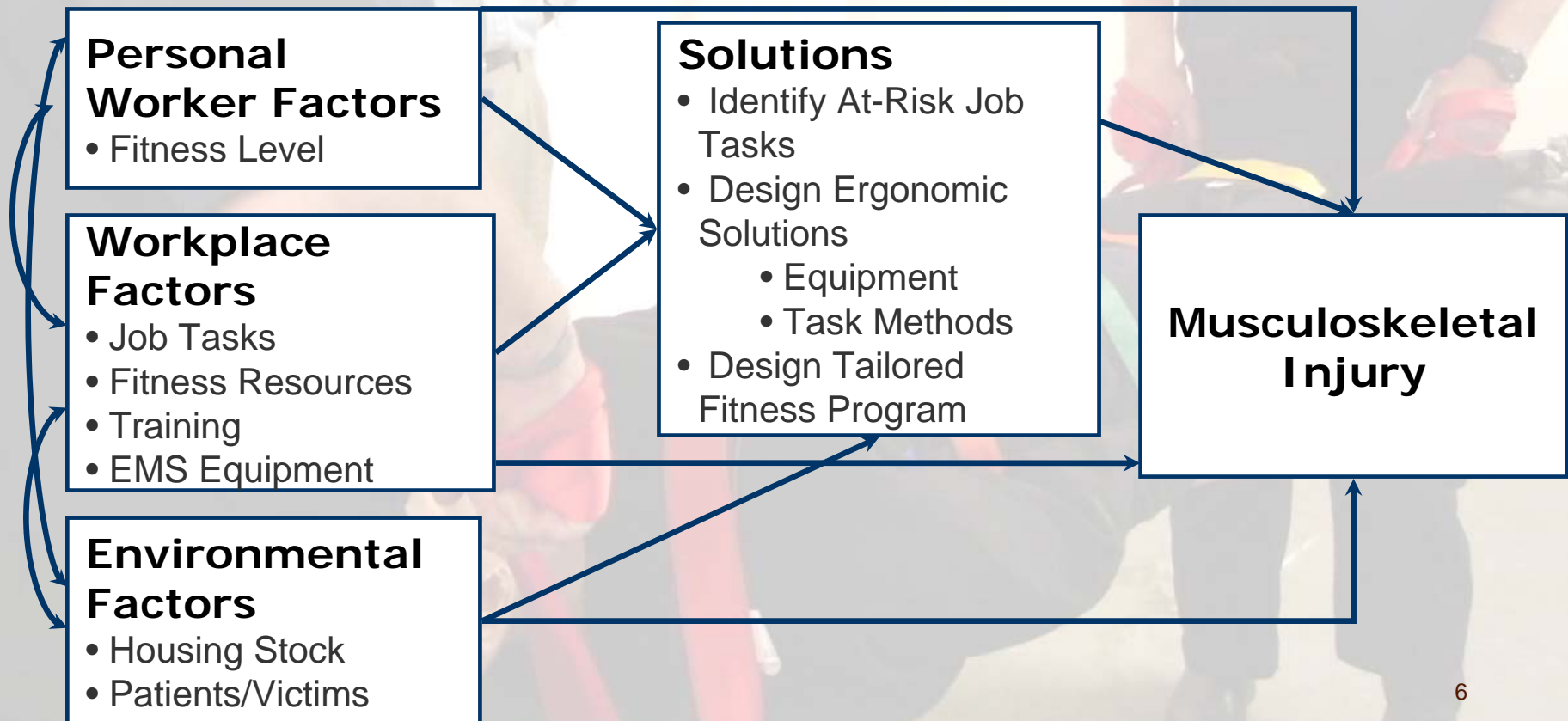
"Solutions?"

"What **personal factors** do you think contribute to musculoskeletal injury on the job?"

"What **external environmental factors** do you think contribute to musculoskeletal injury on the job?"

Focus of our Work To Date

Ecological Model of Factors Influencing Musculoskeletal Injuries



A background image showing two firefighters in blue uniforms with a fire department emblem on the chest. They are standing next to a mannequin lying on a stretcher, which is secured with colorful straps (red, yellow, green, blue). The scene appears to be an indoor training or research facility.

STUDY 2

Ergonomic Study of Fire Service Musculoskeletal Injuries

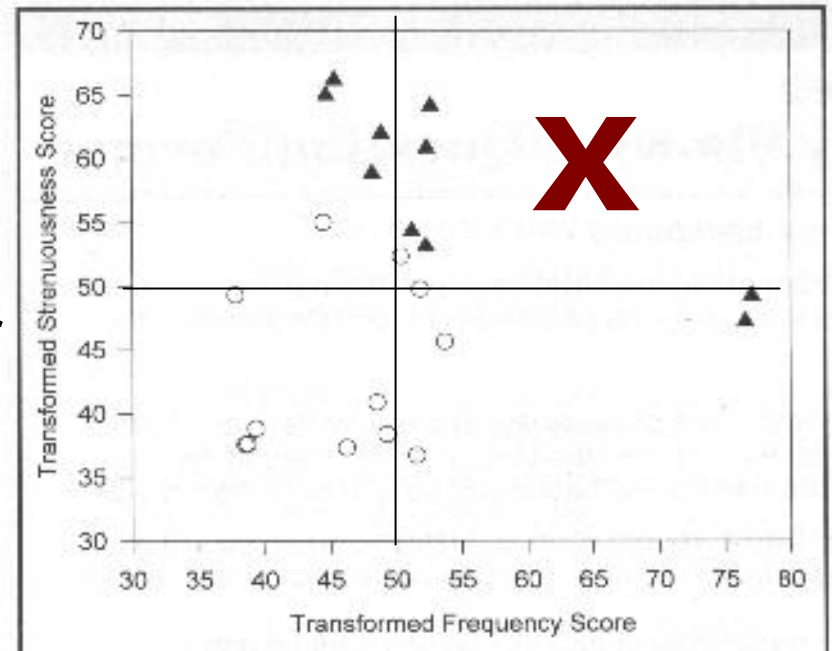
NIOSH R03OH0123

- Purpose
 - Identify and quantify the frequently performed, physically strenuous EMS job tasks
- Methods
 - Interviews (N=29)
 - Surveys (N=374)
 - Simulations of highest risk tasks

STUDY 2

Task Simulations

- Tasks were ranked according to survey results based on
 - Physical strenuousness
 - Frequency
- Top 5 tasks were selected for simulations
 - Lateral and down-the-stair transfers using different equipment
 - 10 two-person teams performed simulations



STUDY 2

Procedures for Task Simulations

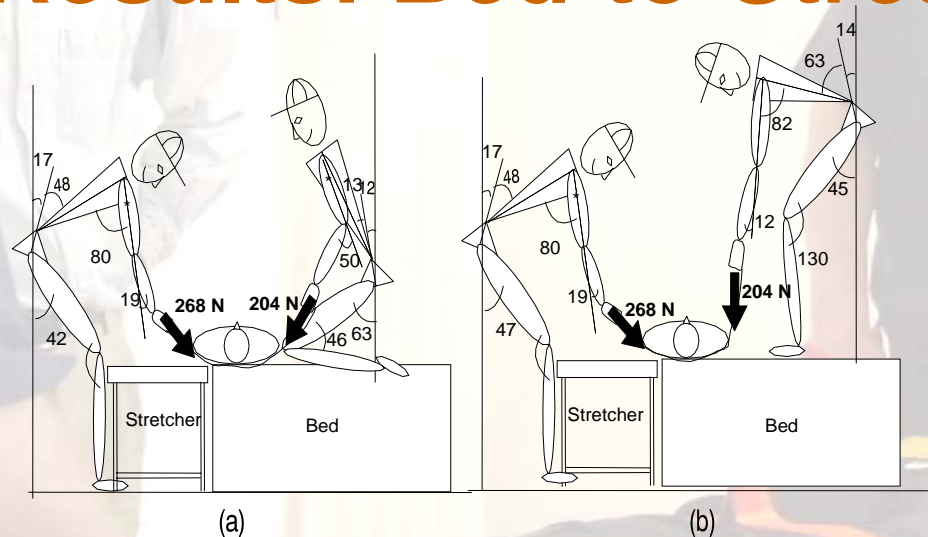
- 105 lb. practice dummy
- Video cameras to measure body postures
- Lumbar Motion Monitor to measure trunk motion
- Hand-held dynamometer to measure hand forces



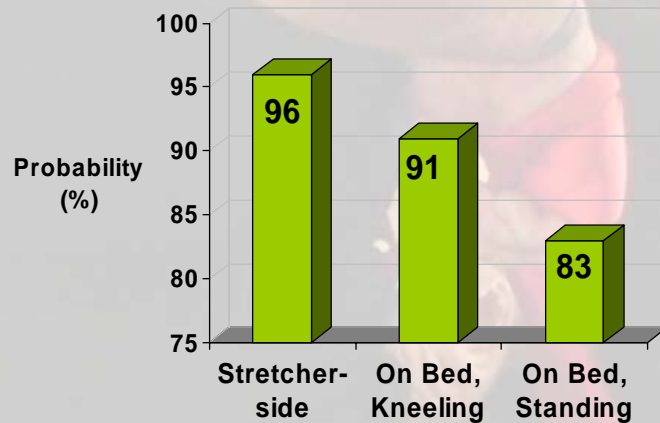
Bed-to-stretcher transfer (kneeling method). Participants instrumented with Lumbar Motion Monitors (LMMs).

STUDY 2

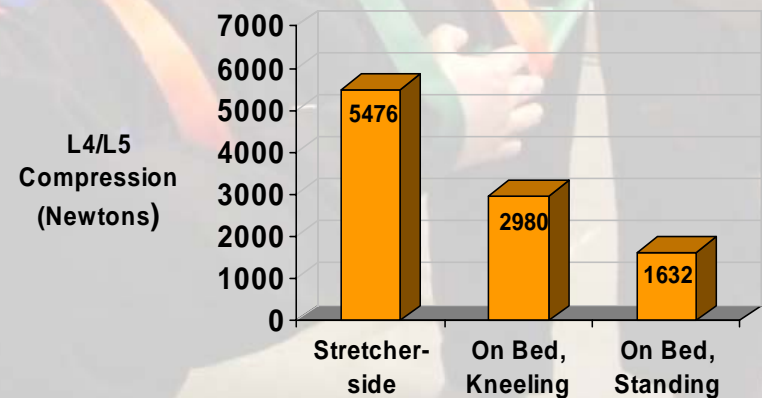
Sample Results: Bed-to-Stretcher



Postural analysis (kneeling vs. standing)



Probability that this task is a high-risk task for low back disorders



Predicted spine (L4/L5) compression values from the 3DSSPP

STUDY 3

Designing Ergonomic Interventions for the Fire Service

NIOSH RO107490

Purpose

- Design, build, test, and evaluate new and modified EMS equipment and work methods that are:
 - Biomechanically validated to be superior to existing counterparts
 - Judged worthy of adoption for use in the field by end users
 - Collaboration with the Fire Service through all phases of research



STUDY 3

Research Phases

- Phase 1
 - Generate concepts through focus groups for redesign of equipment and task methods to address ergonomic concerns identified in previous study
- Phase 2
 - Develop/build equipment and refine work methods
- Phase 3
 - Test equipment and work methods in lab setting
- Phase 4
 - Implement and evaluate the interventions

STUDY 3

Phase 1: Ideas Generated Using Focus Groups

6 Focus Groups

- 24 firefighters/paramedics
- 16 fire departments

"What **criteria** do we need to consider when coming up with ideas?"

"What would your **ideal** piece of **equipment** or **technique** look like?"

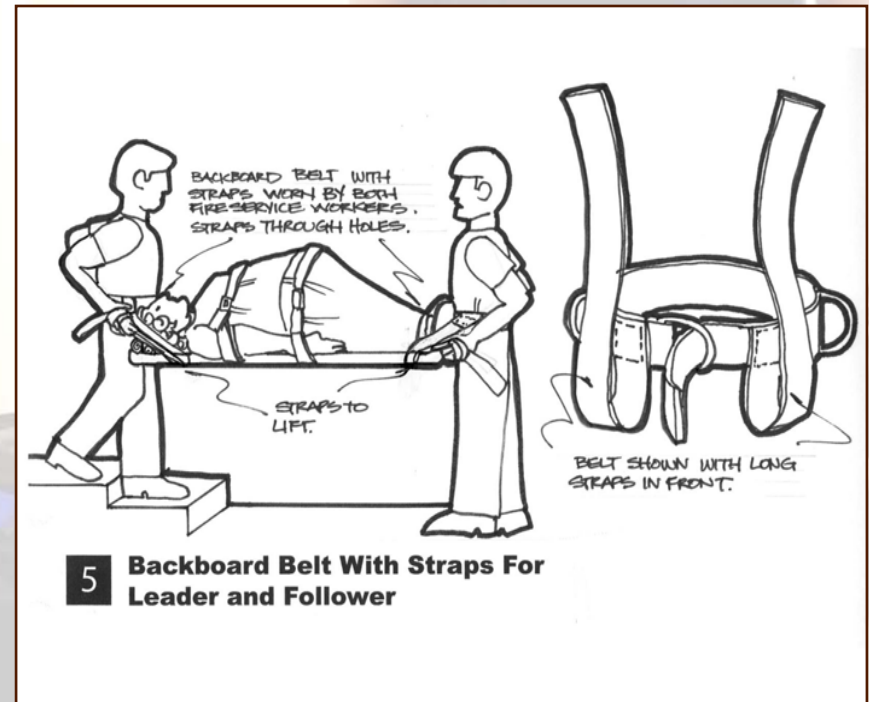
"Affordable, easy to transport and stow, quick to assemble."

24 concepts identified

- **Down-the-stair** transport devices
- **Lateral** transfer devices
- **Bed-to-stairchair** transfer devices
- **Jump kit** redesigns

STUDY 3

Example Sketch from Focus Group



STUDY 3

Phase 2: Build/Develop Equipment

- Iterations and Evolutions
 - Reviewed equipment ideas for ergonomic soundness
 - Modified/refined as needed
- Dialogued with the Fire Service
- Ended up with 8 pieces of equipment and 1 task method for Phase 3

STUDY 3

Phase 3: Task Simulations

- 12 two-person teams completed EMS transfer tasks
 - Comparing conventional vs. new equipment and methods
- Participants...
 - Wore EMG surface electrodes to measure how hard muscles were working
 - Wore sensors to measure body movements
 - Reported on perceived effort and fatigue
- Data analysis is currently under way



STUDY 3

Phase 4: Field Testing

Next steps...

- Apply for patents
- Partner with manufacturer
- Have fire departments evaluate the equipment

Final Product

- Equipment/task methods that are biomechanically validated and judged to be acceptable and usable by end users
- Instructional videos

STUDY 4

Designing a Firefighter Physical Fitness Intervention

A Pilot Study (NINR R15 NR04035)

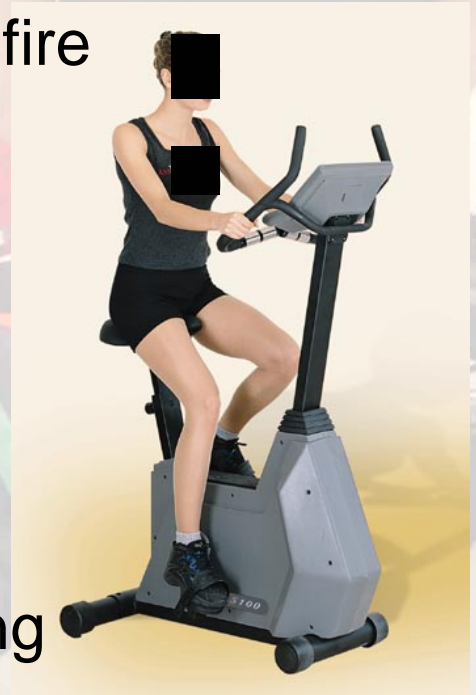
- Purpose
 - Improve physical fitness in order to reduce musculoskeletal injury and cardiovascular risks
- Targeted Benefits
 - Cardiorespiratory fitness
 - Body composition
 - Muscular strength and endurance
 - Flexibility
- Exercises based on
 - Fire suppression tasks
 - EMS tasks
- Participants
 - 21 firefighters from 4 fire departments



STUDY 4

Program Characteristics

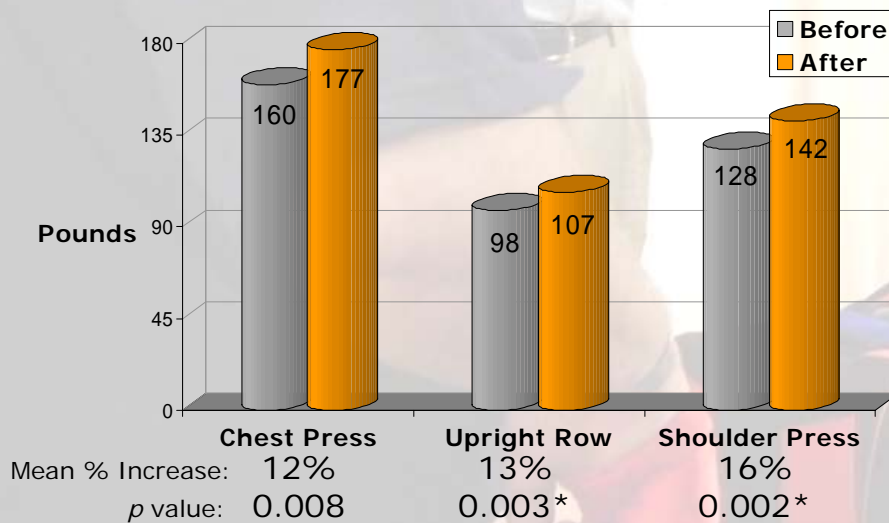
- 12-week program, 30 one-hour sessions
- Participants worked out on shift days at fire departments
- Individually tailored and delivered by interdisciplinary team
- Baseline, 3 month, and 6 month data collected
- Adherence monitored with heart rate monitor watches and exercise logs
- Quasi-experimental design with switching replications among 4 fire departments



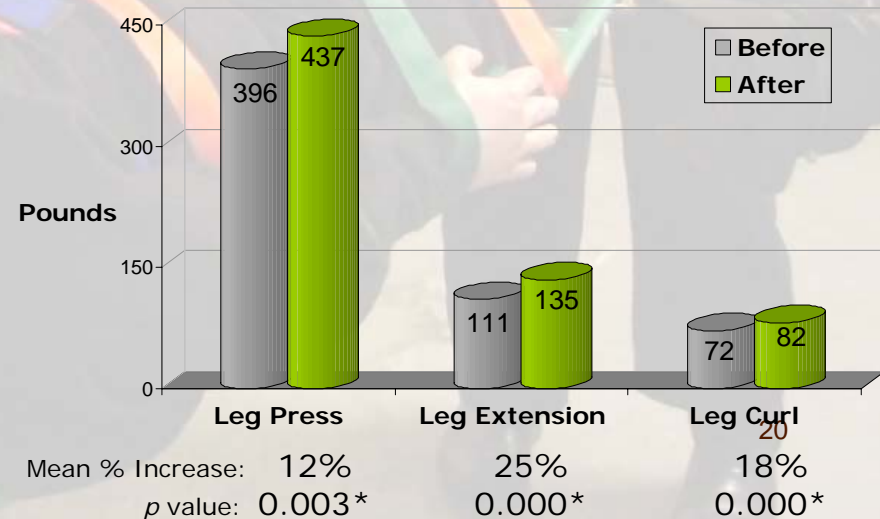
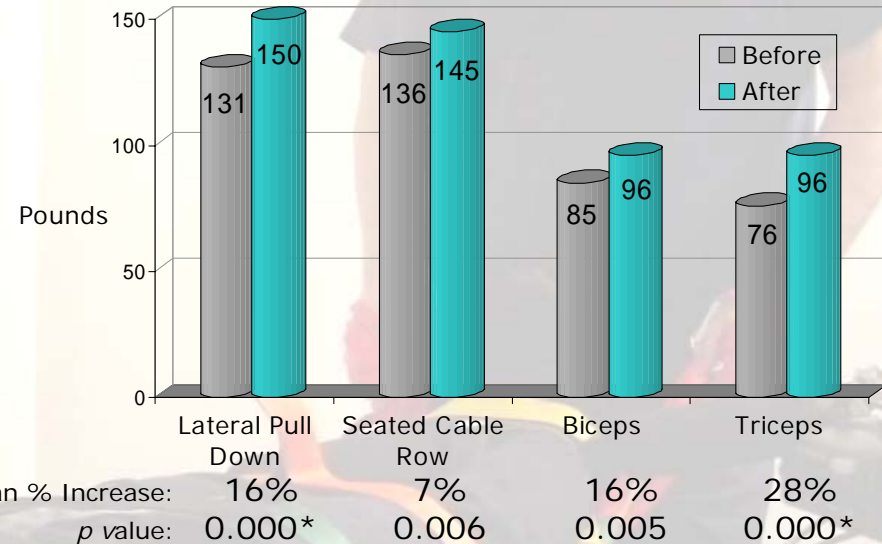
STUDY 4

Strength Measures Before and After Fitness Intervention

Average Changes (n = 21)



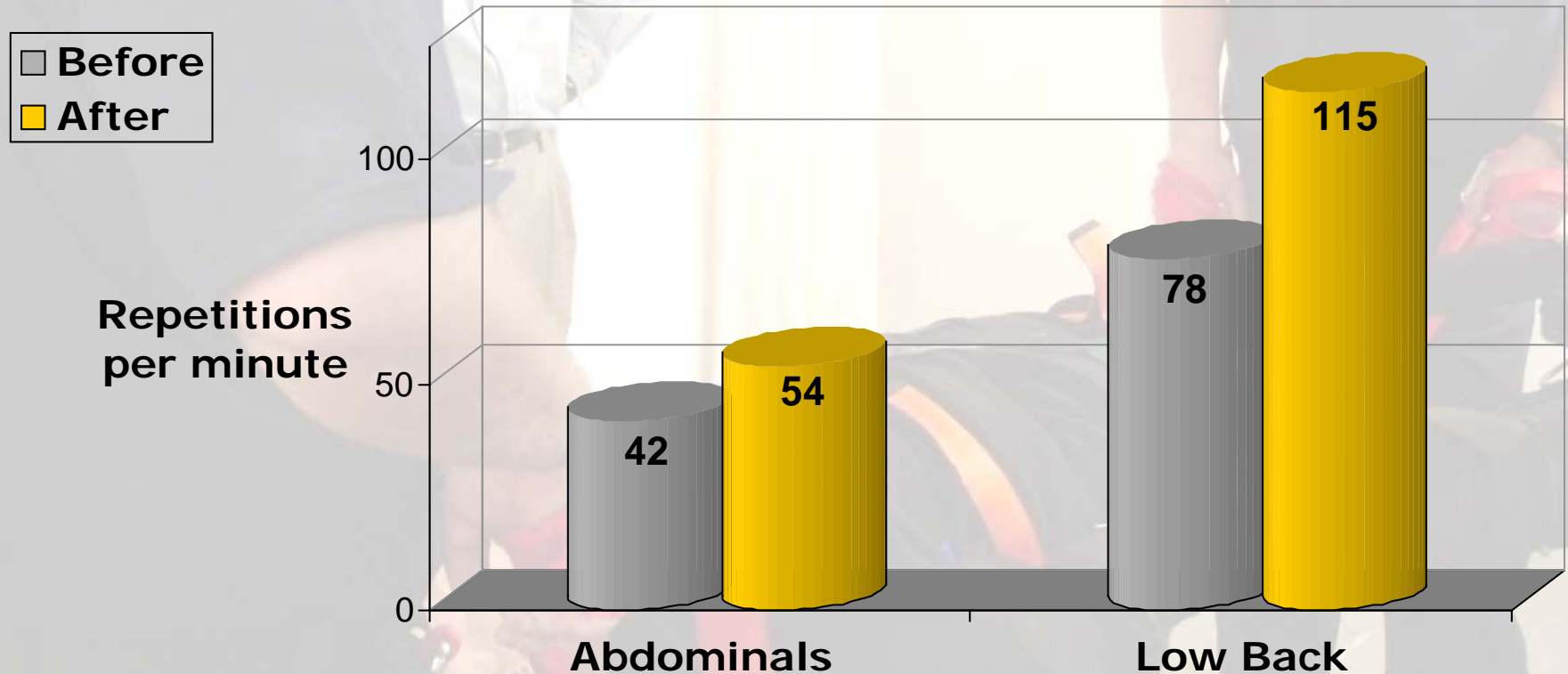
Paired t-tests
Bonferonni correction for multiple tests - $p \leq 0.003$ is considered statistically significant



STUDY 4

Endurance Ratings Before and After Fitness Intervention

Average Changes (n = 21)



Mean % Increase: 31%
p value: 0.000*

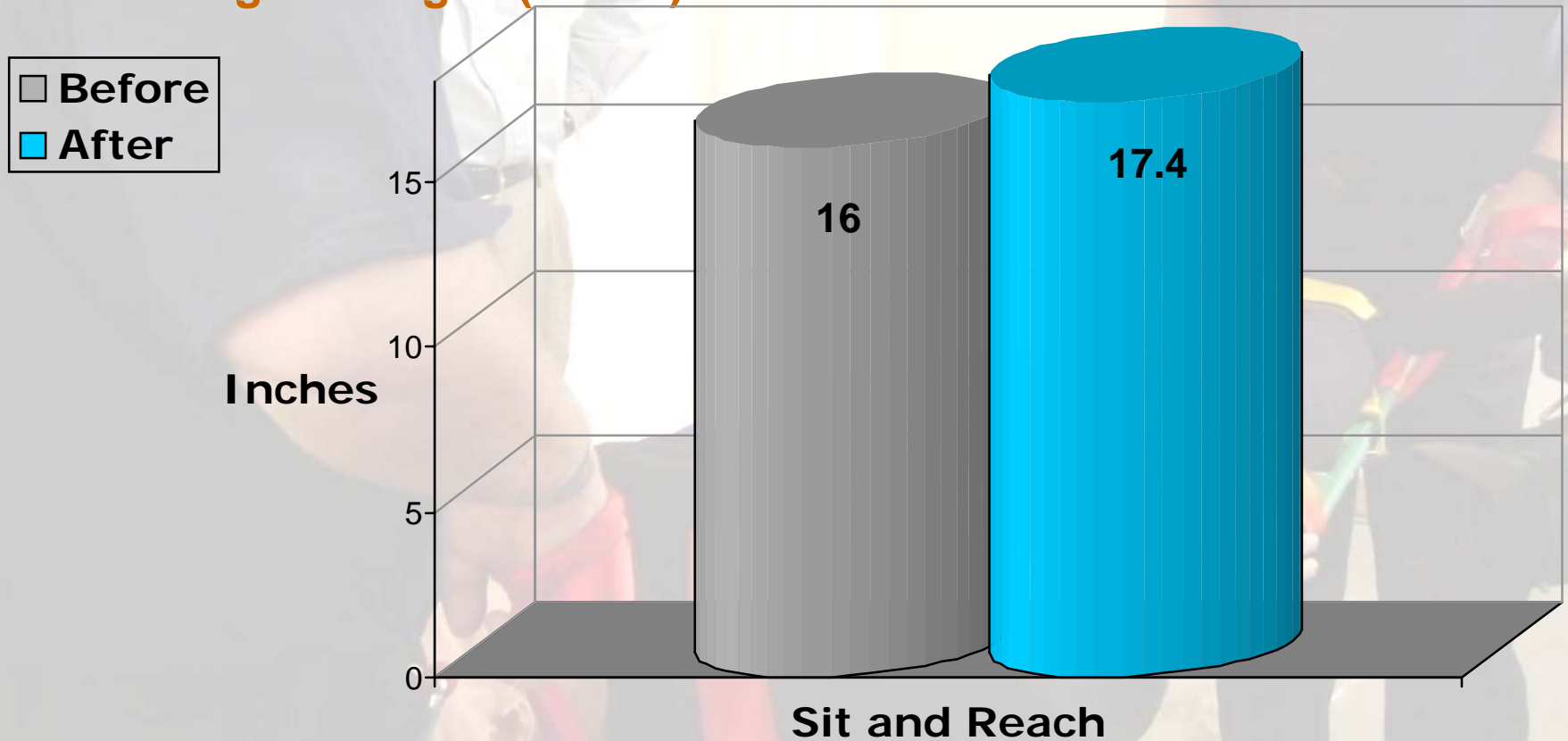
44%
0.000*

* $p \leq 0.003$ is considered statistically significant

STUDY 4

Flexion Ratings Before and After Fitness Intervention

Average Changes (n = 16)



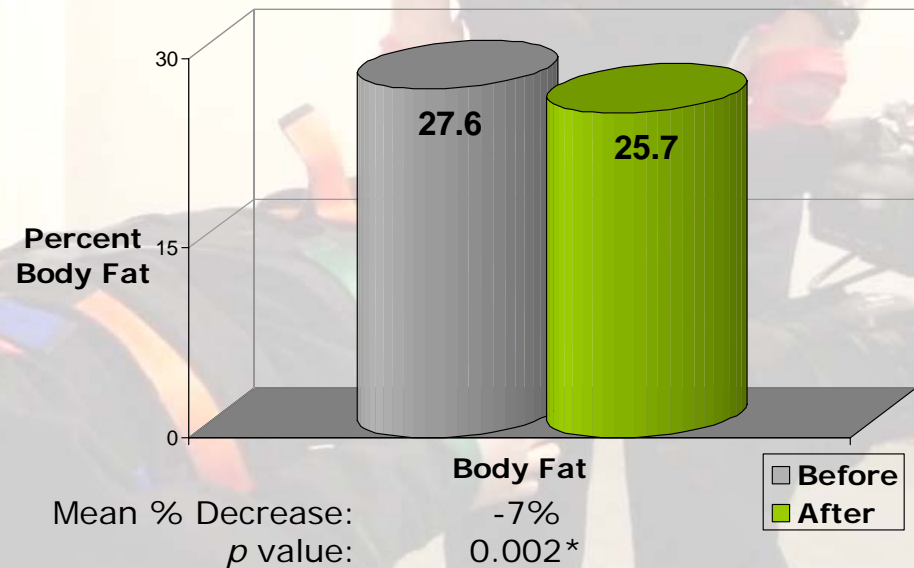
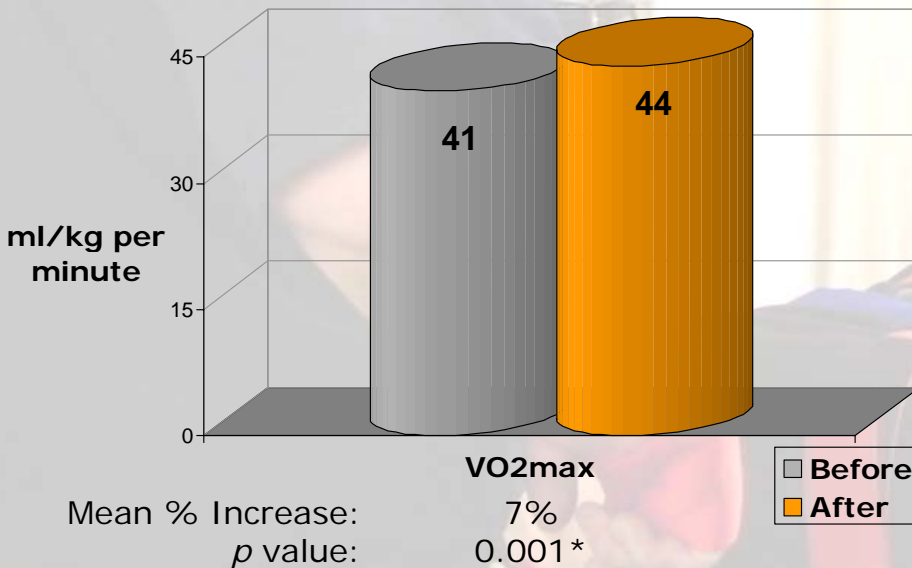
Mean % Increase:
p value:

14%
0.026

STUDY 4

Aerobic Capacity and Percent Body Fat Before and After Fitness Intervention

Average Changes (n = 21)



* $p \leq 0.003$ is considered statistically significant



STUDY 4

Results: Qualitative Evaluation Examples

"... it was **tailored** for me, I wasn't trying to meet some elusive standard out of a magazine or something."

"We had a drill in a warehouse... with **full gear and tanks** and hauling stuff up... and it was **noticeably easier** to do."

"I thought it was excellent. It was tailored specifically for each individual in it. You had **professional** people come in and did **accurate measurements**..."

"... even if you're walking around a big building with the **air pack**... **I wouldn't get nearly as winded** or whatever."



Thank You!

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